

4. RECOMMENDATIONS

As a result of the investigation of this accident, the National Transportation Safety Board makes the following recommendations:

--to the Federal Aviation Administration:

Amend the definition of trace ice contained in Federal Aviation Administration (FAA) Order 7110.10L, "Flight Services," (and in other FAA documents as applicable) so that it does not indicate that trace icing is not hazardous.
(A-98-88)

Require principal operations inspectors (POIs) to discuss the information contained in airplane flight manual revisions and/or manufacturers' operational bulletins with affected air carrier operators and, if the POI determines that the information contained in those publications is important information for flight operations, to encourage the affected air carrier operators to share that information with the pilots who are operating those airplanes. (A-98-89)

With the National Aeronautics and Space Administration and other interested aviation organizations, organize and implement an industry-wide training effort to educate manufacturers, operators, and pilots of air carrier and general aviation turbopropeller-driven airplanes regarding the hazards of thin, possibly imperceptible, rough ice accumulations, the importance of activating the leading edge deicing boots as soon as the airplane enters icing conditions (for those airplanes in which ice bridging is not a concern), and the importance of maintaining minimum airspeeds in icing conditions. (A-98-90)

Require manufacturers and operators of modern turbopropeller-driven airplanes in which ice bridging is not a concern to review and revise the guidance contained in their manuals and training programs to include updated icing information and to emphasize that leading edge deicing boots should be activated as soon as the airplane enters icing conditions. (A-98-91)

With the National Aeronautics and Space Administration and other interested aviation organizations, conduct additional research to identify realistic ice accumulations, to include intercycle and residual ice accumulations and ice accumulations on unprotected surfaces aft of the deicing boots, and to determine the effects and criticality of such ice accumulations; further, the information developed through such research should be incorporated into aircraft certification requirements and pilot training programs at all levels.
(A-98-92)

Actively pursue research with airframe manufacturers and other industry personnel to develop effective ice detection/protection systems that will keep critical airplane surfaces free of ice; then require their installation on newly manufactured and in-service airplanes certificated for flight in icing conditions. (A-98-93)

Require manufacturers of all turbine-engine driven airplanes (including the EMB-120) to provide minimum maneuvering airspeed information for all airplane configurations, phases, and conditions of flight (icing and nonicing conditions); minimum airspeeds also should take into consideration the effects of various types, amounts, and locations of ice accumulation, including thin amounts of very rough ice, ice accumulated in supercooled large droplet icing conditions, and tailplane icing. (A-98-94)

Require the operators of all turbine-engine driven airplanes (including the EMB-120) to incorporate the manufacturer's minimum maneuvering airspeeds for various airplane configurations and phases and conditions of flight in their operating manuals and pilot training programs in a clear and concise manner, with emphasis on maintaining minimum safe airspeeds while operating in icing conditions. (A-98-95)

Require the manufacturers and operators of all airplanes that are certificated to operate in icing conditions to install stall warning/protection systems that provide a cockpit warning (aural warning and/or stick shaker) before the onset of stall when the airplane is operating in icing conditions. (A-98-96)

Require all operators of turbopropeller-driven air carrier airplanes to require pilots to disengage the autopilot and fly the airplane manually when they activate the anti-ice systems. (A-98-97)

Require all manufacturers of transport-category airplanes to incorporate logic into all new and existing transport-category airplanes that have autopilots installed to provide a cockpit aural warning to alert pilots when the airplane's bank and/or pitch exceeds the autopilot's maximum bank and/or pitch command limits. (A-98-98)

Expedite the research, development, and implementation of revisions to the icing certification testing regulations to ensure that airplanes are adequately tested for the conditions in which they are certificated to operate; the research should include identification (and incorporation into icing certification requirements) of realistic ice shapes and their effects and criticality. (A-98-99)

When the revised icing certification standards and criteria are complete, review the icing certification of all turbopropeller-driven airplanes that are currently certificated for operation in icing conditions and perform additional testing and take action as required to ensure that these airplanes fulfill the requirements of the revised icing certification standards. (A-98-100)

Review turbopropeller-driven airplane manufacturers' airplane flight manuals and air carrier flightcrew operating manuals (where applicable) to ensure that these manuals provide operational procedures for flight in icing conditions, including the activation of leading edge deicing boots, the use of increased airspeeds, and disengagement of autopilot systems before entering icing conditions (that is, when other anti-icing systems have traditionally been activated). (A-98-101)

Require air carriers to adopt the operating procedures contained in the manufacturer's airplane flight manual and subsequent approved revisions or provide written justification that an equivalent safety level results from an alternative procedure. (A-98-102)

Ensure that flight standards personnel at all levels (from aircraft evaluation groups to certificate management offices) are informed about all manufacturer operational bulletins and airplane flight manual revisions, including the background and justification for the revision. (A-98-103)

Revise its current EMB-120 flight data recorder (FDR) system inspection procedure to include a FDR readout and evaluation of parameter values from normal operations to ensure a more accurate assessment of the operating status of the flight control position sensors on board the airplane. (A-98-104)

Reemphasize to pilots, on a periodic basis, their responsibility to report meteorological conditions that may adversely affect the safety of other flights, such as in-flight icing and turbulence, to the appropriate facility as soon as practicable. (A-98-105)

Amend Federal Aviation Administration Order 7110.65, "Air Traffic Control," to require that automatic terminal information service broadcasts include information regarding the existence of pilot reports of icing conditions in that airport terminal's environment (and adjacent airport terminal environments as meteorologically pertinent and operationally feasible) as soon as practicable after receipt of the pilot report. (A-98-106)

--to the National Aeronautics and Space Administration:

With the Federal Aviation Administration and other interested aviation organizations, organize and implement an industry-wide training effort to educate manufacturers, operators, and pilots of air carrier and general aviation turbopropeller-driven airplanes regarding the hazards of thin, possibly imperceptible, rough ice accumulations, the importance of activating the leading edge deicing boots as soon as the airplane enters icing conditions (for those airplanes in which ice bridging is not a concern), and the importance of maintaining minimum airspeeds in icing conditions. (A-98-107)

With the Federal Aviation Administration and other interested aviation organizations, conduct additional research to identify realistic ice accumulations, to include intercycle and residual ice accumulations and ice accumulations on unprotected surfaces aft of the deicing boots, and to determine the effects and criticality of such ice accumulations; further, the information developed through such research should be incorporated into aircraft certification requirements and pilot training programs at all levels. (A-98-108)

In addition, the Safety Board reiterates the following safety recommendations to the Federal Aviation Administration:

Revise the icing criteria published in 14 Code of Federal Regulations Parts 23 and 25, in light of both recent research into aircraft ice accretion under varying conditions of liquid water content, drop size distribution and temperature, and recent development in both the design and use of aircraft. Also, expand the Part 25 appendix C icing certification envelope to include freezing drizzle/freezing rain and mixed water/ice crystal conditions as necessary. (A-96-54)

Revise the icing certification testing regulation to ensure that airplanes are properly tested for all conditions in which they are authorized to operate, or are otherwise shown to be capable of safe flight into such conditions. If safe operations cannot be demonstrated by the manufacturer, operational limitations should be imposed to prohibit flight in such conditions and flightcrews should be provided with the means to positively determine when they are in icing conditions that exceed the limits for aircraft certification. (A-96-56)